

Amendments to the Specification:

After the title, please insert the following subheading and paragraph [0001]:

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application is entitled to the benefit of and incorporates by reference essential subject matter disclosed in International Patent Application No. PCT/GB2004/001561 filed on April 8, 2004 and Great Britain Patent Application No. 0308729.3 filed April 15, 2003.

Before paragraph [0002], insert the following subheading:

FIELD OF THE INVENTION

Before paragraph [0003], please insert the following subheading:

BACKGROUND OF THE INVENTION

Before paragraph [0011], please insert the following subheading:

BRIEF SUMMARY OF THE INVENTION

Before paragraph [0048], please insert the following subheading:

BRIEF DESCRIPTION OF THE DRAWINGS

Please insert paragraphs [0048], [0050], [0051] and [0052] as follows:

[0048] Now having described the invention in general terms, embodiments of the invention shall be described in details with reference to the drawings in which:

[0050] Figure 2 is a schematic cross-sectional illustration of a typical homopolar generator that has been designed to enable the conductive disc to intersect both the forward and the return magnetic fields produced by an electromagnetic coil.

[0051] Figure 3 is schematic illustration of a diesel engine generating system capable of producing either AC electricity for local supply or DC electricity for a water electrolysis unit.

[0052] Figure 4 is a schematic illustration of the exhaust gas abatement system that may be required for an engine combusting a variety of fossil and non-fossil fuels.

Before paragraph [0053], please insert the following subheading:

DETAILED DESCRIPTION OF THE INVENTION

Please amend the following paragraphs:

[0053] In Figure 1, a shaft 3 runs through the ~~center~~center of both poles of a magnet 2, and in a manner whereby shaft 3 can freely rotate within the magnet 2. A metal disc 1 is fixed to shaft 3 and is spatially arranged so that the metal disc 1 is centrally located between the north and south poles of the magnet 2.

[0055] Rotation of disc 1 in the magnetic field generates a voltage between the ~~center~~center of the disc and the rim of the disc. An electric charge, which can be collected by electrical contact brushes placed at the rim and at the ~~center~~center of the disc, is produced in disc 1.

[0056] The efficiency of a homopolar generator is greatly improved if an annular magnetic field, whose axis passes through the ~~center~~center of the drive shaft, is used in the system. When an annular magnetic field is used, the electromotive force developed in any ring is constant so that all current paths in the disc are radially orientated.

[0057] Improvements in the performance of homopolar generators have tended to concentrate on ~~utilizing~~utilizing as much of the available magnetic field as possible. Particular emphasis has been placed on the shape and position of the magnets used in homopolar machines and also on the relative spatial arrangement of the magnets and the conductive disc.

[0059] The magnetic field produced by an annular magnet or an annular electromagnetic coil has an axis of rotational symmetry and the field is toroidal in character. Lines of magnetic flux emanate from the ~~center~~center of the magnet or coil

and initially flow outwards in a forward direction. The magnetic flux then moves in a circular toroidal manner until the magnetic flux eventually returns back to the rear of the magnet or coil.

[0060] Homopolar machines were originally designed with the conductive disc positioned so that the disc only intersected the magnetic field travelling in a forward direction, as illustrated in the basic homopolar machine shown in Figure 1. The performance of a homopolar generator can be improved if both the forward and the return magnetic fields produced by a magnet or a coil are ~~utilised~~ utilized to generate current in the disc.

Please delete paragraph [0061].

Please amend the following paragraphs:

[0065] A thin and substantially flat conductive metal disc 5 is connected centrally to a shaft 6 in a manner whereby rotation of shaft 6, by an external rotary motive force, would also rotate disc 5 about a central axis that is perpendicular to the disc ~~whilst~~ while being simultaneously coincident with the central axis 9 of the magnetic field. The disc 5 is positioned so that the bottom surface of the disc is in close proximity to the annular coil 7.

[0066] The metal disc 5 and the annular coil 7 are spatially arranged so that the forward magnetic field 10 passes through the central portion of disc 5, ~~whilst~~ while the return magnetic field 11 passes through the outer portion of disc 5. The central portion of disc 5, which is subjected to the forward magnetic field 10, is separated from the outer portion of disc 5, which is subjected to the return magnetic field 11, by a ring of insulating material 13. The ring of insulating material 13 runs radially around the disc 5 at a fixed distance from the ~~centre~~ center of the disc

[0068] In this particular embodiment of a homopolar generator, the annular coil 7 is surrounded by a core 8 of highly permeable magnetic material such as soft iron. The iron core 8 further concentrates the return magnetic field 11 towards coil 7, so that more of the return field passes through the outer region of disc 5, thus

allowing disc 5 to ~~utilise~~ utilize more of the magnetic field produced by the annular coil 7.

[0069] A slide arm mechanism 15 is fixed in position above the top surface of the conductive disc 5, and in a manner whereby the slide arm 15 extends from the ~~centre~~ center to the outside of the disc.

[0070] For example, the inner end of slide arm 15 is in close proximity to drive shaft 6, ~~whilst~~ while the outer end of slide arm 15 extends over the outer rim of disc 5. Electrical current contact brushes 16, 18 and 19 are located on the underside of slide arm 15.

[0071] Brush 16 collects the current produced on the central portion of disc 5. An interconnecting slide arrangement between arm 15 and brush 16 allows the position of brush 16, relative to the top surface of disc 5, to be adjusted by sliding brush ~~[[13]]~~ 16 along arm 15 until the brush is at the required position on the inner portion of disc 5.

[0073] This arrangement allows fine adjustment of the contact brushes 16 and 18, until the brushes are at the point of optimum current on the inner and outer portions respectively of the conductive disc 5. The contact brushes 16 and 18 can then be locked in place on the slide arm 15 by using interlocking ~~fixings~~ fixtures mounted on the brushes and the slide arm respectively.

[0083] For example, oxygen enrichment would allow locally available biofuels, such as vegetable oils, to be burned efficiently in an engine, as well as petroleum fuel oils. In tropical countries this would allow palm oil and coconut oil to be used as fuel, ~~whilst~~ while groundnut oil could be used in sub-tropical regions, and rapeseed oil, sunflower oil and soybean oil could be used in temperate zones. Animal fats and waste cooking oil could also be used as biofuels in an enriched oxygen diesel engine, as could natural alcohol fermented from locally grown sugar or starch producing plants.

[0084] This provides a high degree of flexibility for the integrated renewable energy system. For example, during the day the engine could be run on say locally available non-fossil biofuels to generate AC 'green' electricity for local supply, ~~whilst~~ while during the night the engine could be run on either biofuel or petroleum fuel oil to generate the DC electricity required for the electrolysis of water.

[0087] Both the oxygen and the hydrogen from the water electrolysis process would have applications in the integrated renewable energy system. The oxygen could be used to produce the enriched oxygen combustion atmosphere for the engine, ~~whilst~~ while hydrogen could be used as either a clean burning renewable gaseous fuel or as a reactant, along with oxygen, in fuel cells to produce 'green' electricity.

[0088] The integrated renewable energy system will now be described with reference to illustrations given in Figures 3 and 4, ~~where;~~

Please delete paragraphs [0089] and [0090].

Please amend the following paragraphs:

[0091] In Figure 3, a compression ignition engine ~~[[17]]~~ 34 has a drive shaft coupled to both an AC electrical generator ~~[[18]]~~ 35 and a DC homopolar generator ~~[[19]]~~ 36. In practice the homopolar generator ~~[[19]]~~ 36 would consist of a multiple combination of homopolar generators, connected together either in series and/or in parallel, to produce sufficient current to be able to run a similar multiple combination of water electrolysis units.

[0093] Fuel from storage tank 20 would be heated and filtered, as necessary, before being transferred to the fuel injectors of engine ~~[[17]]~~ 34. The fuel injectors would inject fuel at the appropriate time into the combustion chambers of the engine.

[0097] The motion of the pistons up and down the cylinders in the engine would be transferred as a rotary motion to the drive shaft of the engine, and the drive shaft would be coupled to both an AC generator ~~[[18]]~~ 35 and a homopolar

generator [[19]] 36. The drive shaft would be capable of being readily engaged to or disengaged from the AC generator [[18]] 35 and the DC homopolar generator [[19]] 36 respectively, so that the drive shaft would only be coupled to one generator at a time.

[0098] When driving the AC generator [[18]] 35, the AC electricity produced by the genset would be supplied to an electric circuit that would distribute the electricity to meet local demands. Preferably a non-fossil biofuel would be used when generating the AC electricity so that 'green' electricity was produced for local use.

[0099] When driving the homopolar generator [[19]] 36, the DC electricity produced by the genset would be supplied by an electric circuit to a water electrolysis unit 23. Either non-fossil biofuel or fossil petroleum fuel could be used to generate the DC electricity.

[00105] The electrolyte in each cell would typically be a 25 % solution of potassium hydroxide, and there would be means to continually replenish the cells with fresh water. Application of the electric current produced by the homopolar generator [[19]] 36 to the electrolysis cells produces hydrogen at the cathodes of the cells and oxygen at the anodes.

[00109] The oxygen cycle in the integrated energy system would then be complete, because oxygen from tank 21 would be used to produce the enriched oxygen combustion atmosphere for the engine [[17]] 34 that powers the system. Excess oxygen in tanks 21 would be delivered to a packaging plant (not shown in Figure 3) where the oxygen would either be compressed and packed into cylinders or be liquefied and packed into tanks.

[00110] In the integrated renewable energy system illustrated in Figure 3, oxygen enrichment would enable the compression ignition engine [[17]] 34 to burn a variety of fossil and non-fossil fuel oils. The exhaust gas from the engine would therefore need to be cleaned to an appropriate degree before the exhaust gas was

released to the atmosphere, and the abatement required would mainly be dependent on the type of fuel being burned in the engine.

[00111] A typical engine abatement system is described in Figure 4. In Figure 4, the compression ignition engine [[17]] 34 is again coupled to the AC generator [[18]] 35 and the DC homopolar generator [[19]] 36. Fuels are stored in fuel tanks [[20]] 37, although only one tank is shown in Figure 4, and an enriched oxygen combustion atmosphere is supplied to the engine.

[00112] The condition of the exhaust gas emitted from engine [[17]] 34 will be dependent on the particular fuel being burned in the engine.

[00117] The engine combustion system illustrated in Figure 4 is a combined heat and power (CHP) process where the exhaust gas passes through a boiler 29 in order to recover the waste heat in the exhaust gas. The steam from boiler 29 could be used to drive a steam turbine [[30]] 38, which would produce more AC electricity for local use, and/or the steam could be used for local heating. The size of the compression engine, and hence the amount of heat available in the engine exhaust, would determine whether or not a steam boiler in the exhaust would be a practical proposition. Heat is also available from the engine cooling system and this source of waste heat can also be used for local heating purposes.

[00124] Both the hydrogen and the oxygen produced by the electrolysis of water are valuable products that have potential applications in a variety of end uses. For example, hydrogen is a unique energy resource with particular potential as a clean burning transport fuel, ~~while~~ while oxygen is already used in a number of industrial applications including combustion processes, chemical processes, aerobic fermentation, water purification and medical uses. Hydrogen and oxygen can also be used together as the reactants in a fuel cell to produce clean, 'green' electricity.

Please insert the following new paragraph [0127]:

[0127] While the present invention has been illustrated and described with respect to a particular embodiment thereof, it should be appreciated by those of ordinary skill in the art that various modifications to this invention may be made without departing from the spirit and scope of the present invention.